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**Ai et al.**

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(54) **ELECTRONIC DEVICES WITH FLEXIBLE DISPLAYS AND HINGES**

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CPC ..... **G06F 1/1681** (2013.01); **G06F 1/1652** (2013.01); **G06F 1/1618** (2013.01)

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See application file for complete search history.

(56) **References Cited**

**U.S. PATENT DOCUMENTS**

9,204,565 B1 12/2015 Lee et al.  
9,348,450 B1\* 5/2016 Kim ..... G06F 1/1681

9,541,962 B2 1/2017 Siddiqui  
9,544,993 B2 1/2017 Lee et al.  
2011/0150453 A1\* 6/2011 Chang ..... G03B 35/08 396/326  
2012/0307423 A1\* 12/2012 Bohn ..... G06F 1/1641 361/679.01  
2012/0307472 A1 12/2012 Bohn et al.  
2013/0243608 A1\* 9/2013 Sakamoto ..... F04B 49/22 417/26  
2013/0342090 A1\* 12/2013 Ahn ..... G09F 9/33 312/258  
2013/0342094 A1\* 12/2013 Walters ..... G09F 19/00 312/319.2

(Continued)

**OTHER PUBLICATIONS**

Stic Search (Year: 2019).\*

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(57) **ABSTRACT**

An electronic device may have a flexible display that overlaps an axis. The display may be supported by a housing. The housing may have first and second portions that rotate relative to each other about the axis. The housing may be placed in an unfolded configuration to support the display in a planar state. The housing may also be placed in a folded configuration by rotating the first and second portions relative to each other. A hinge mechanism may be used to ensure adequate separation between the first and second portions when the housing is bent. Movable flaps may be retracted when the housing is bent to create room for a bent portion of the display.

**28 Claims, 37 Drawing Sheets**

